UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
BIN C15700
Seattle, WA 98115-0070

August 5, 2002

James B. Burby, P.E.
United States Department of the Interior
911 NE Eleventh Avenue
Portland, Oregon 97232-4181

Re: Endangered Species Act Biological Opinion and Magnuson-Stevens Fishery Management and Conservation Act Consultation for Quilcene National Fish Hatchery, Bank Stabilization Project, Big Quilcene River, Jefferson County, Washington (NOAA Fisheries No. WHB-02-107)

Dear Mr. Burby:

Enclosed is the National Marine Fisheries Service's (National Oceanic and Atmospheric Administration (NOAA Fisheries)) biological opinion (Opinion) concluding formal Endangered Species Act consultation on the big Quilcene River bank stabilization project in Jefferson County, Washington. The project was described in the Biological Evaluation; "Big Quilcene River Streambank Stabilization Project", received March 8, 2002, and further clarified in an addendum document June 2002. This Opinion addresses Hood Canal Summer-run chum salmon (*Oncorhynchus keta*).

NOAA Fisheries has determined that the proposed action is not likely to jeopardize the continued existence of the listed species described above. An Incidental Take Statement provides non-discretionary terms and conditions to minimize the potential for incidental take of listed species.

In addition, this document also serves as consultation on Essential Fish Habitat for chinook (*O. tshawytscha*), coho *(O. kisutch)* and pink salmon (*O. gorbuscha*) under the Magnuson-Stevens Act and its implementing regulations (50 C.F.R. Part 600). If you have any questions regarding this Opinion, please contact Dan Guy at (360) 534-9342 of my staff in the Washington State Branch Office.

Sincerely,

For Michael R Crouse

D. Robert Lohn
Regional Administrator

Enclosure

Endangered Species Act - Section 7 Consultation
BIOLOGICAL OPINION
&
Magnuson-Stevens Fishery Conservation and Management Act
ESSENTIAL FISH HABITAT CONSULTATION

Big Quilcene River Streambank Stabilization Project (WHB-02-107)

Agency: United States Fish and Wildlife Service

Consultation Conducted by: National Oceanic and Atmospheric Administration Fisheries
Northwest Region
Washington State Habitat Branch

Approved: for Michael R Crouse
D. Robert Lohn
Regional Administrator

Date Issued: August 5, 2002

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1.0 INTRODUCTION

This document has been prepared in response to a request for consultation under the Endangered Species Act (ESA) of 1973, as amended, 16 U.S.C. 1531, *et. seq.* and transmits the National Marine Fisheries Service's (National Oceanic and Atmospheric Administration (NOAA Fisheries)) Biological Opinion (Opinion) and Essential Fish Habitat (EFH) consultation based on our review of the effects of the proposed bank stabilization project on the Big Quilcene River. The project site is in Jefferson County, Washington, within the Evolutionarily Significant Unit (ESU) of the threatened Hood Canal summer-run (HCS) chum (*Oncorhynchus keta*). While the project is located in the ESU of Puget Sound chinook salmon (*O. tshawytscha*) the naturally-spawning descendants from the spring-run chinook salmon program at the Quilcene National Hatchery (Quilcene and Sol Duc stocks) and their progeny are not considered part of the Puget Sound ESU(64 Fed. Reg. 14308; March 24, 1999). The Quilcene is also EFH for chinook, coho (*O. kisutch*) and Puget Sound pink salmon (*O. gorbuscha*).

1.1 Background and Consultation History

On March 2, 2002, the NOAA Fisheries received a biological evaluation (BE) and cover letter from the US Department of the Interior, US Fish and Wildlife Service (FWS) Division of Engineering, for a bank stabilization project at the Quilcene National Fish Hatchery on the Big Quilcene River in Jefferson County. The Federal action described in the BE proposes the placement of large riprap along a portion of the left bank of the river immediately downstream of the hatchery weir. The BE concludes that the action would not likely adversely affect the listed species, HCS chum.

On March 11, 2002, NOAA Fisheries advised Mr. James Burby, P.E., of the Division of Engineering, in a telephone conversation that it would not be concurring with the effects determination that had been presented in the BE. A site visit was arranged through a series of telephone messages and conversations with Mr. Burby and a project consultant. On April 29, 2002 NOAA Fisheries personnel met with the Mr. Burby, and other staff from Interior's Engineering Division as well as Quilcene Hatchery managers, Larry Telles and Ron Wong, Daniel Turner of MWH Consulting, Dave Zajac, FWS - Division of Fisheries and Watershed Assessment, and potential contractors.

At NOAA Fisheries request, MWH, the project design consultant, provided additional information to clarify the effects of the action. The project design was also altered to increase the amount of large woody debris (LWD) that will be incorporated into the project. The FWS and MWH also explained in more detail how the site will be de-watered during project construction. The detail and thoroughness of the de-watering plan clarified the downstream sedimentation effects concerns. NOAA Fisheries was also, as a result of the site visit, able to evaluate the lack of alternatives for bank stabilization available to the action agency at this project site. Written documentation of the above described site visit as well as EFH consultation information was received in electronic format from MWH on June 13, 2002. Receipt of this additional required information initiated formal consultation on that date.

This Opinion considers the potential effects of the proposed action on HCS chum salmon, which occur in the proposed project area. HCS chum salmon were listed as threatened under the ESA on March 25, 1999 (64 Fed. Reg. 14508) and protective regulations were issued on July 10, 2000 (65 Fed. Reg. 42422). The objective of this Opinion is to determine whether the proposed action is likely to jeopardize the continued existence of HCS chum salmon. This consultation is conducted pursuant to section 7(a)(2) of the ESA and its implementing regulations, 50 C.F.R. 402.

1.2 Description of the Proposed Action

The FWS proposes to construct a bank stabilization project with the inclusion of LWD in the lower reaches of the project to enhance salmonid rearing habitat. The action includes the de-watering of the left bank of the Big Quilcene River for approximately 300 feet immediately downstream of the hatchery weir. A rubber bladder will be laid downstream parallel to the left bank. The bladder will be filled with water pumped from an on-hatchery raceway to isolate the river flow from the project site. A PVC liner (45MIL) will form an impermeable channel between the inflated bladder and the right bank. The river flow will be directed into this lined channel. Approximately 450 cubic yards of cemented gravels and hardpan will be excavated from a trench along the left bank for the toe-rock of the riprap bank protection material. The excavated material will be removed to an upland disposal site. About 860 cubic yards of large rock (5-foot diameter), with smaller rock to fill the voids, will be used to form the new toe anchor. The bank riprap will be built to the elevation of ordinary high water mark (OHWM). The in-water work window (July 15-Sept. 1) for this project has been established to avoid juvenile out-migrants and to be completed prior to the return of adult HCS chum that are predominately hatchery origin returns.

In addition to the bank lining structure, four rock groins, positioned at 60-foot intervals, are proposed for this project. The most upstream structure will be placed approximately 90 feet downstream of the fish ladder. Each groin will extend upstream at a 30-degree angle, with the upstream groin measuring 30 feet in length followed by 25, 20, and 15 foot long groins downstream. The upper three groins are represented in project drawings to include j-hook type veins at their ends to assist in stabilization of the thalweg in the project area. The rock used in the groins is included in the 860 cubic yard total.

At the lower end of the project area, FWS proposes to locate several pieces of LWD. This structure will include multiple pieces of both tree bole and root wad. The LWD will include both deciduous and conifer species. The wood pieces will be anchored by burying in the bank, locating and anchoring in the groins, and by cable anchoring if needed. The project plans indicate the quantity of LWD pieces to exceed 20 tree boles and root wads.

Upslope of OHWM the steepened bank will be terraced for equipment location and in preparation for a bio-engineered bank stabilization treatment. This bio-engineering treatment will include geotextile wrapped soils laid in lifts up the slope. Live stake bundles of appropriate species will be laid between each soil wrap layer. Due to live-planting survival concerns the bio-engineering application will not be put in place until early fall (October) so that weather and precipitation can assist in plant survival. Placement of this application will occur outside of OHWM and will be placed from the upslope roadway. Methods to avoid sedimentation into the river have been incorporated.

1.3 Description of the Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 C.F.R. 402.02). Direct effects occur at the project site and may extend upstream or downstream based on the potential for impairing fish passage, hydraulics, sediment and pollutant discharge, and the extent of riparian habitat modifications. Indirect affects may occur throughout the watershed where actions lead to additional activities or affect ecological functions contributing to stream degradation. For this consultation, the action area includes the affected streambed, bankline, adjacent riparian zone, and aquatic areas of the Big Quilcene River from immediately upstream of the hatchery at approximately river-mile (RM) 2.8 downstream to the head of tidal influence, approximately RM 0.5.

2.0 ENDANGERED SPECIES ACT CONSULTATION

The ESA (16 U.S.C. 1531-1544), amended in 1988, establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants and the habitat on which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with FWS and NOAA Fisheries, as appropriate, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or to adversely modify or destroy their designated critical habitats. This Opinion is the product of an interagency consultation pursuant to Section 7(a)(2) of the ESA and implementing regulations found at 50 C.F.R. Part 402.

2.1 Status of the Species

One distinguishing characteristic of this group of summer chum populations is an early nearshore marine area, adult run timing (early August into October). This early timing creates a temporal separation from the more abundant indigenous fall chum stocks which spawn in the same area, allowing for reproductive isolation between summer and fall chum stocks in the region (WDF et al. 1993). The distance between summer chum spawning tributaries of Hood Canal and the eastern Strait of Juan de Fuca, and the rest of the Puget Sound streams, creates a geographical separation among the stocks.

Hood Canal and Strait of Juan de Fuca summer chum populations are one of three genetically distinct lineages of chum salmon in the Pacific Northwest region (Johnson et al. 1997). Washington Department of Fish and Wildlife (WDFW) concluded that the Hood Canal and Strait of Juan de Fuca summer chum comprise a distinct major ancestral lineage, defined as stocks whose shared genetic characteristics suggest a distant common ancestry, and substantial reproductive isolation from other chum lineages (Phelps et al.1995, WDFW 1995). NOAA Fisheries' (Johnson et al. 1997) designated Hood Canal and Strait of Juan de Fuca summer chum as an evolutionarily significant unit, based upon distinctive life history and genetic traits. Genetic differences between summer chum and all other chum stocks in the U.S. and British Columbia are a result of long-standing reproductive isolation of the Hood Canal and Strait of Juan de Fuca summer chum populations (Tynan 1992). This isolation has been afforded by a significantly different migration and escapement timing, and geographic separation from other chum stocks in the Pacific Northwest (Tynan 1992, Johnson et al. 1997)

2.1.1 Distribution

A total of 11 streams in Hood Canal have been identified as recently having indigenous summer chum populations: Big Quilcene River, Little Quilcene River, Dosewallips River, Duckabush River, Hamma Hamma River, Lilliwaup Creek, Union River, Tahuya River, Dewatto River, Anderson Creek, and Big Beef Creek (Tynan 1992). Summer chum are occasionally observed in other Hood Canal drainages, including the Skokomish River which was once a major summer chum stream. Salmon and Steelhead Stock Inventory (SASSI) (WDF et al. 1993) lists two, distinct summer chum populations in Hood Canal - the Union River population and a group including all other Hood Canal summer production streams. Summer chum salmon populations in the eastern Strait of Juan de Fuca have been reported in Chimacum Creek, located near Port Hadlock in Admiralty Inlet, Snow and Salmon creeks in Discovery Bay and Jimmycomelately Creek in Sequim Bay. (WDF et al. 1993, Sele 1995). Recent stock assessment data indicate that summer chum also return to the Dungeness River, but the magnitude of returns is unknown (Sele 1995).

Summer chum in the region use Hood Canal and the Strait of Juan de Fuca estuarine and marine areas for rearing and seaward migration as juveniles. The fish spend two to four years in northeast Pacific Ocean feeding areas prior to migrating southward during the summer months as maturing adults along the coasts of Alaska and British Columbia in returning to their natal streams. Adults may delay migration in extreme terminal marine areas for up to several weeks before entering the streams to spawn. Spawning occurs in the lower reaches of each summer chum stream.

2.1.2 Life History Strategy

Summer chum have evolved to exploit freshwater and estuarine habitats during periods, and for durations, when interaction with other Pacific salmon species and races is minimized. The uniqueness of summer chum is best characterized by their late summer entry into freshwater spawning areas, and their late winter/early spring arrival in the estuaries as seaward-migrating juveniles.

Summer chum spawning occurs from late August through late October, generally within the lowest one to two miles of the tributaries. Depending upon temperature regimes in spawning streams, eggs reach the eyed stage after approximately 4-6 weeks of incubation in the redds, and hatching occurs approximately 8 weeks after spawning (L. Telles, Quilcene National Fish Hatchery (QNFH), Quilcene, WA, pers. comm., 1996). Alevins develop in the redds for an additional 10-12 weeks before emerging as fry between February and the last week of May. Estimated peak emergence timings for Hood Canal and Strait of Juan de Fuca summer chum populations are March 22 and April 4 respectively. By contrast, indigenous fall chum stocks spawn in Hood Canal streams predominately in November and December, and the resulting fry emerge from the spawning gravels approximately one month later than summer chum salmon, between late April and mid-May (Koski 1975, Tynan 1997). Chum fry recovered in Hood Canal marine areas during the summer chum emergence period range in size from 35-44milllimeters.

Freshwater Juvenile Life History - Incubation - Developing chum salmon incubate as eggs or sac fry in the gravel for five or six months after fertilization, a time period determined mainly by ambient temperature regimes characteristic of Pacific Northwest streams (Bakkala 1970, Koski 1975, Schreiner 1977, Salo 1991). Stream flow, dissolved oxygen levels, gravel composition, spawning time, spawning density and genetic characteristics also affect the rate of egg/alevin development, and hence gravel residence time (Bakkala 1970, Koski 1975, Schroder 1981, Salo 1991). The earliest eggs deposited enter the tender stage starting the first week in September, with the majority of incubating eggs reaching the eyed stage by November 3. Bakkala (1970) reported total gravel residence times for chum ranging from 78 to 183 days across the range of chum salmon distribution, dependent on stream temperature. Koski (1975) documented an average gravel residence time from spawning to 50 percent (peak) population emergence for Big Beef Creek summer chum of 166 days, with 95 percent emergence after 177 days. Telles (1996) reported 100 percent emergence (swim-up) of 1994 brood Big Quilcene River summer chum 111 days after fertilization at QNFH.

Emergence and Downstream Migration - Summer chum fry emergence timing in Hood Canal can range from the first week in February ("warm" years and/or earlier spawn date years) through the second week in April (colder and/or later spawn date years). The 10 percent, 50 percent and 90 percent average emergence dates across years reported for Big Beef Creek summer chum were March 13, March 18, and March 27, respectively (Tynan 1997). The 10 percent to 90 percent emergence range observed across years was February 7 through April 14. Strait of Juan de Fuca summer chum generally emerge later than Hood Canal summers due to colder stream incubation temperatures. Estimated, average 10 percent, 50 percent, and 90 percent emergence dates for Strait of Juan de Fuca summer chum are March 6, April 4, and April 26, respectively. The 10 percent to 90 percent emergence range estimated across years for Strait chum is February 15 through May 26 (Tynan 1997).

Fry emerge with darkness, and immediately commence migration downstream to estuarine areas (Bakkala 1970, Koski 1975, Schreiner 1977, Koski 1981, Salo 1991), with total brood year migration from freshwater ending within 30 days for smaller streams and rivers (Salo 1991). Emerging chum fry have been shown to become very active with darkness (Hoar 1951), preferring the swiftest areas of downstream flow and exhibiting strong negative rheotaxis, often swimming more rapidly than the current (Hoar 1951, Neave 1955).

Estuarine and Marine Life History- Upon arrival in the estuary, chum salmon fry inhabit nearshore areas (Schreiner 1977, Bax 1982, Bax 1983, Whitmus 1985). Chum fry have a preferred depth of between 1.5-5.0 meters at this time (Allen 1974) and are thought to be concentrated in the top few meters of the water column both day and night (Bax 1983b). In Puget Sound, chum fry have been observed through annual estuarine area fry surveys to reside for their first few weeks in the top 2-3 centimeters of surface waters and extremely close to the shoreline (Ron Egan, WDFW, Olympia, WA, pers. comm.). Iwata (1982) reported that, in Japan, chum orientated in stratified surface waters (20-100 cm depth) upon arrival in the estuary, showing a very strong preference for lower salinity water (10 to 14 ppt) found above the freshwater/saltwater interface, perhaps as a seawater acclimation mechanism. This nearshore and surface behavior could also be linked to survival, as small size exposes youngest fry to heavy predation. Onshore location may protect the fry from larger fish (Gerke and Kaczynski 1972, Schreiner 1977) and schooling behavior may be an adaptation to predator avoidance (Feller 1974).

Chum fry arriving in the Hood Canal estuary are initially widely dispersed (Bax 1982), but form loose aggregations oriented to the shoreline within a few days (Schreiner 1977, Bax 1983, Whitmus, 1985). These aggregations occur in daylight hours only, and tend to break up after dark (Feller 1974), regrouping nearshore at dawn the following morning (Schreiner 1977, Bax 1983). Bax et al. (1978) reported that chum fry at this initial stage of out-migration use areas predominately close to shore. "Early run" chum fry in Hood Canal (defined as chum juveniles migrating during February and March) usually occupy sublittoral seagrass beds with residence time of about one week (Wissmar and Simenstad 1980). Schreiner (1977) reported that Hood Canal chum maintained a nearshore distribution until they reached a size of 45-50milllimeters, at which time they moved to deeper off-shore areas.

Food - Chum fry captured in nearshore environments during out-migration in upper Hood Canal were found to prey predominantly on epibenthic organisms, mainly harpacticoid copepods and gammarid amphipods (Bax et al. 1978, Simenstad et al. 1980). Diet changed to predominantly pelagic organisms in early May for fry migrating in off-shore areas. Dabob Bay chum fry were reported to feed continuously (day and night) in using nearshore areas as a source of food (Feller 1974). Feller (1974) and Gerke and Kaczynski (1972) documented initial preference (and predominance in the diet) of epibenthic prey by chum fry in Dabob Bay, followed by a gradual switch to pelagic prey as time progressed. Several researchers have documented a reliance on drift insects by migrating chum fry in British Columbia (Mason 1974) and in Dabob Bay, Hood Canal (Gerke and Kaczynski 1972). Hatchery-released chum fry in southern Hood Canal were found initially to prey almost exclusively on terrestrial insects, likely made available as drift from the Skokomish River (Whitmus 1985). Faster-migrating fry that had moved further north of the Skokomish delta were found to feed entirely on neritic and epibenthic organisms. Simenstad et al. (1980) showed a gradual decrease in the epibenthic fraction of stomach contents as the chum increased in size. Migration off-shore could result from opportunistic movement of fry to take advantage of larger, more prevalent prey organisms in the neritic environment (Bax 1983).

Juvenile Seaward Migration - Summer chum entering the estuary are thought to immediately commence migration seaward, migrating at a rate of 7 - 14 kilometers per day (Tynan 1997). Rapid seaward movement may reflect either “active” migration in response to low food availability or predator avoidance, or “passive” migration, brought on by strong, prevailing south/southwest weather systems that accelerates surface flows, and migrating fry present during the late winter-early spring time period, northward (Bax et al. 1978, Simenstad et al. 1980, Bax 1982, Bax 1983). Assuming a migration speed of 7 kilometers per day, the southernmost out-migrating fry population in Hood Canal would exit the Canal 14 days after entering seawater, with 90 percent of the annual population exiting by April 28 each year, on average. Applying the same migration speed, summer chum fry originating in Strait of Juan de Fuca streams would exit the Discovery Bay region 13 days after entering seawater, or by June 8 each year (90 percent completion).

Ocean Migration - After two to four years of rearing in the northeast Pacific Ocean, maturing Puget Sound-origin chum salmon follow a southerly migration path parallel to the coastlines of southeast Alaska and British Columbia (Neave et al. 1976, Salo 1991, Myers 1993). The precise timing of this migration from Gulf of Alaska waters for Hood Canal summer chum is unknown. Genetic stock identification data collected from Canadian Strait of Juan de Fuca commercial net fisheries (LeClair 1995, 1996), Canadian fishery recoveries in 1995 of coded wire tagged Big Quilcene summers (PSMFC data, August 14, 1996) and a single recovery in Big Beef Creek of a summer chum tagged in a southeast Alaska ocean fishery study (Koski 1975), suggest that the southerly ocean migration down the Pacific Northwest coast and into the Strait of Juan de Fuca likely commences in mid-July, and continues through at least early September. Migrational timing of Strait of Juan de Fuca summer chum into Washington marine waters appears earlier than arrival timing observed for Hood Canal summer chum. The stocks in this region enter the terminal area (the Strait) from the first week of July through September (WDFW and WWTIT 1994). GSI data collected from Canadian net fisheries at the entrance to the Strait suggests that Hood Canal and Strait of Juan de Fuca summer chum are present through August and into early September (LeClair 1995, 1996).

Adult Nearshore Migration - Summer chum mature primarily at 3 and 4 years of age with low numbers returning at age 5 (there are rare observations of age 2- and 6-year fish). They enter the Hood Canal terminal area from early August through the end of September (WDFW and WWTIT 1994). Entry pattern data for Quilcene Bay provided by Lampsakis (1994) suggest that summer chum enter extreme terminal marine areas adjacent to natal streams from the third week in August, through the first week in October, with a central 80percent run timing of August 30 through September 28, and a peak on September 16.

Comparison of extreme terminal area entry timing in Quilcene Bay with spawning ground timing estimates developed from Big Quilcene River data, suggests that summer chum may mill in front of their stream of origin for up to ten to twelve days before entering freshwater (with shorter milling times later in the run). Thus it is assumed that summer chum observed on spawning grounds entered the river five days earlier, based on a ten day average survey life. This behavior is likely related to the amount of time required for the chum to complete maturation and to acclimate to freshwater, but is also affected by available stream flows.

Adult Freshwater Migration and Spawning - Spawning ground entry timing in Hood Canal ranges from late August through mid-October. Lampsakis (1994) reported a central 80 percent spawning ground timing in the Big Quilcene River of September 11 through October 14, with a peak on or about September 28, based on 22 years of spawning ground survey data. Strait of Juan de Fuca summer chum begin spawning during the first week of September, reaching completion in mid-October (WDFW and WWTIT 1994). Time density analysis of Snow, Salmon and Jimmycomelately creek spawner survey data for the lower portions of the drainages indicates a central 80 percent spawning ground timing of September 16 through October 20, with an average peak on October 2 (Lampsakis 1994).

Spawning - HCS chum typically spawn soon after entering freshwater in the lowest reaches of natal streams (Koski 1975, Schroder 1977, Johnson et al. 1997). This characteristic may reflect an adaptation to low flows present during their late summer/early fall spawning ground migration timing, which confine spawning to areas with sufficient water volume. Spawning in lower river reaches during low flows, however, confines incubating eggs to center channel areas, exposing the eggs to increased risk of egg pocket scouring during freshets. Koski (1975) noted that Big Beef Creek summer chum spawning took place predominantly in the lower 0.8 km of stream. Cederholm (1972) reported that 100 percent of the summer chum run to Big Beef Creek in 1966 and 1967 spawned in the lower 0.6 km of the creek. WDFW documentation of summer chum spawning in the Quilcene indicates that 90 percent of spawning occurs in the lower mile of the 2.2 miles of river accessible to salmonids. Summer chum spawn in the lower mile of Salmon Creek and in the lower one-half mile of Snow and Jimmycomelately creeks (WDFW and WWTIT 1994). As with HCS chum, low summer-time flows likely have acted to confine summer chum spawning in this region to the lowest reaches of each production stream.

2.1.3 Population Trends

Of the sixteen populations of summer chum identified in this ESU, seven are considered to be “functionally extinct” (Skokomish, Finch Cr., Anderson Cr., Dewatto, Tahuya, Big Beef Cr., and Chimacum). The remaining nine populations are well distributed throughout the ESU except for the eastern side of Hood Canal; those populations were among the least productive in the ESU. (WDFW and PNPTT 2000)

This ESU has two geographically distinct regions: the Strait of Juan de Fuca and Hood Canal. Although the populations all share similar life history traits, the summer chum populations in the two regions are affected by different environmental and harvest impacts and display varying survival patterns and stock status trends.

In the Hood Canal region, summer chum are still found in the Dosewallips, Duckabush, Hamma Hamma, Lilliwaup, Big and Little Quilcene, and Union Rivers. A few chum have been observed in other systems during the summer chum migration period, but these observations are sporadic and are thought to be strays from other areas. Although abundance was high in the late 1970's, abundance for most Hood Canal summer chum populations declined rapidly beginning in 1979, and has remained at depressed levels. The terminal run size for the Hood Canal summer chum stocks averaged 28,971 during the 1974-1978 period, declining to an average of 4,132 during 1979-1993. Abundance during the 1995-1998 period has improved, averaging 10,844. However, much of the increase in abundance can be attributed to a supplementation program for the Big/Little Quilcene River summer chum stock begun in 1992. Escapements in the Union have been stable or increasing in relation to historical levels. Escapements to the Dosewallips and Duckabush rivers have been generally above threshold levels of concern, but are highly variable. Escapements in the Hamma Hamma and particularly the Lilliwaup have been below threshold escapement levels that represent an increased risk to the population too often in recent years. (Table 1)

Supplementation programs were instituted in 1992 for the Big/Little Quilcene, the Hamma Hamma and Lilliwaup stocks due to the assessment of high risk of extinction for these stocks (WDFW and PNPTT 2000). The Quilcene program has been quite successful at increasing the number of returning adults. The Hamma Hamma and Lilliwaup programs have been hampered by an inability to collect sufficient broodstock. A re-introduction program was also started in Big Beef Creek using the Quilcene stock. It is too early to assess the success of that program. Other re-introduction programs may be initiated in the future, but will depend on the development of additional broodstock sources so as not to become dependent on Quilcene as the sole donor stock.

In the Strait of Juan de Fuca, summer chum stocks are found in Snow, Salmon, and Jimmycomelately Creeks and the Dungeness River. (The Snow and Salmon are treated as a single stock complex.) The terminal abundance of summer chum in the Strait of Juan de Fuca region began to decline in 1989, a decade after the decline observed for summer chum in Hood Canal. Terminal abundance declined from an average of 1,923 for the 1974-1988 period to a average of 477 during 1989-1994 period. During the most recent period (1995-1998) the average for the region has increased to 1,039, however, much of the increase may be due to the supplementation program in the Snow/Salmon system that was initiated in 1992. Escapements in Jimmycomelately have continued to be poor, i.e., less than 100 spawners in the last three years. There are no systematic surveys for summer chum in the Dungeness. However, their presence is routinely noted in surveys for other species. The status of the summer chum population in the Dungeness is therefore unknown.

An assessment of the habitat in the Strait of Juan de Fuca chum watersheds concluded that these were among the most degraded watersheds in the ESU (WDFW and PNPTT 2000). Winter peak and summer low flows, and sediment aggradation are considered problems in the Dungeness, Jimmycomelately and Snow Creeks. Improvement in habitat conditions will be essential for successful recovery of summer chum in this region of the ESU.

2.2 Evaluating the Proposed Action

The standards for determining jeopardy are set forth in section 7(a)(2) of the ESA as defined by 50 C.F.R. Part 402 (the consultation regulations). In conducting analyses of habitat-altering actions under section 7 of the ESA, NOAA Fisheries uses the following steps: (1) Consider the status and biological requirements of the species; (2) evaluate the relevance of the environmental baseline in the action area to the species' current status; (3) determine the effects of the proposed or continuing action on the species; (4) consider cumulative effects; and (5) determine whether the proposed action, in light of the above factors, is likely to appreciably reduce the likelihood of species survival in the wild. In completing this step of the analysis, NOAA Fisheries determines whether the action under consultation, together with all cumulative effects when added to the environmental baseline, is likely to jeopardize the continued existence of the listed species or result in destruction, adversely modify their critical habitat, or both. If NOAA Fisheries finds that the action is likely to jeopardize the listed species, NOAA Fisheries must identify reasonable and prudent alternatives for the action.

2.2.1 Biological Requirements

The first step in the methods NOAA Fisheries uses for applying the ESA to listed salmon is to define the biological requirements of the species most relevant to each consultation. NOAA Fisheries also considers the current status of the listed species taking into account population size, trends, distribution and genetic diversity. To assess the current status of the listed species, NOAA Fisheries starts with the determinations made in its decision to list HCS chum salmon for ESA protection and also considers new data available that are relevant to the determination (Johnson et al. 1997).

The relevant biological requirements are those necessary for HCS chum to survive and recover to naturally reproducing population levels at which protection under the ESA would become unnecessary. Adequate population levels must safeguard the genetic diversity of the listed stock, enhance their capacity to adapt to various environmental conditions, and allow them to become self-sustaining in the natural environment.

The Quilcene National Fish Hatchery has, since 1992, provided hatchery supplementation of HCS chum utilizing brood stock colleted from the tribal coho fishery in the bay, in-river collection, and fish captured at the hatchery. This supplementation program is scheduled to end soon. At the completion of this program HCS chum stocks will depend on natural reproduction to sustain their numbers. For this consultation, the biological requirements of the listed species under consideration are improved habitat characteristics that function to support successful spawning, rearing and migration.

The project elements that will provide improvements to the riparian habitats will provide future temperature amelioration through shading, improving rearing success. Improved riparian structure will also contribute to the detrital based food web which improves rearing success, although freshwater rearing time for HCS chum is limited. The inclusion of LWD in the project design adds complexity to the aquatic habitat which improves juvenile rearing and also adult holding water habitat. The inclusion of groins in the project also adds an element of habitat diversity and has the potential to facilitate the accumulation of spawning gravels that improves the opportunity for successful spawning. While the short-term effects of construction and riparian disruption are generally negative, the combined effects of this proposed action tend to provide for improved functioning condition. In conducting analysis of habitat-altering actions, NOAA Fisheries usually defines the biological requirements using a concept called Properly Functioning Condition (PFC) and uses a "habitat approach" in its analysis.[1]

The status of the HCS chum, based upon their risk of extinction, is currently being assessed by a NOAA Fisheries biological review team (BRT) in a status review update for all west coast salmon populations. For the interim period the stock remains listed as threatened and needed protective measures remain required.

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[1] National Marine Fisheries Service, Northwest Region. 26 August 1999. The Habitat Approach: Implementation of Section 7 of the Endangered Species Act for Actions Affecting the Habitat of Pacific Anadromous Salmonids. Guidance memorandum from Assistant Regional Administrators for Habitat Conservation and Protected Resources to staff. 13 pages. NOAA Fisheries, 525 NE Oregon St, Ste 500, Portland, OR 97232-2737.

		Hood Canal Region											Strait of Juan de Fuca	
Return Year	**HC Summer Chum ESU**	*Skokomish*	*Tahuya*	Union	B.Quilcene/L. Quilcene	*Big Beef*	*Anderson*	Dosewallips	Duckabush	Hamma Hamma	Lilliwaup	*Dewatto*	Snow/ Salmon	Jimmy comelately
1974	14,548	475	882	68	841	75	-	3,600	3,588	2,453	617	181	1,330	438
1975	29,176	2,601	3,352	203	3,061	1,333	226	2,604	2,598	8,495	1,643	1,427	1,287	348
1976	66,803	4,865	18,661	583	9,861	1,368	250	3,492	6,507	8,165	7,918	3,640	1,129	365
1977	16,790	921	2,129	220	1,742	325	28	3,461	2,641	1,803	1,221	654	1,239	405
1978	27,158	261	548	132	5,279	749	18	2,093	2,090	9,045	2,743	1,121	2,293	787
1979	8,798	100	377	313	620	200	6	1,246	1,247	3,244	526	158	591	170
1980	17,036	78	904	1,051	1,770	310	5	3,061	2,082	828	1,248	591	3,783	1,326
1981	5,416	219	286	84	589	147	2	103	909	1,512	598	84	681	203
1982	9,198	253	267	476	1,161	-	-	1,006	1,369	1,589	261	65	2,152	599
1983	4,411	45	188	372	2,157	-	-	84	105	249	39	33	885	254
1984	4,686	91	196	268	1,372	27	1	260	366	208	258	61	1,212	367
1985	2,715	111	214	585	577	-	-	380	48	372	161	33	171	61
1986	8,085	68	243	4,217	1,325	-	-	124	385	376	216	45	795	292
1987	5,610	61	145	794	2,482	9	-	13	18	38	51	8	1,527	464
1988	8,776	45	153	664	2,269	-	-	679	511	452	290	24	2,638	1,052
1989	2,569	38	21	1,042	781	-	-	34	127	34	100	5	215	173
1990	1,344	75	8	364	389	-	-	9	49	106	3	-	278	63
1991	1,906	3	5	228	853	-	-	262	107	72	33	34	184	125
1992	3,660	7	-	140	952	-	-	657	619	123	90	-	454	616
1993	1,344	2	-	252	163	-	-	105	105	69	72	1	463	110
1994	2,633	1	-	742	744	-	-	226	264	372	106	-	163	15
1995	10,332	-	-	723	4,589	-	-	2,796	828	478	79	-	616	223
1996	21,762	35	5	496	9,597	-	-	7,005	2,661	777	100	-	1,054	30
1997	10,113	-	-	482	8,006	-	-	47	475	104	31	7	901	61
1998	5326	5	-	244	3,066	-	-	336	226	143	24	12	1,172	98
1974-78 Avg.	30,895	1,825	5,114	241	4,157	770	104	3,050	3,485	5,992	2,829	1,405		
1979-94 Avg.	5,512	75	188	724	1,138	43	1	516	519	603	253	71		
1974-88 Avg.	15,280												1,448	475
1989-94 Avg.	2,243												293	184
1995-98 Avg.	11,883	10	1	486	6,314	-	-	2,546	1,048	375	59	5	936	103

Table 1. Hood Canal summer chum terminal abundance by population and year.

(Skokomish River includes only catch data. No escapement data is available.)

2.2.2 Environmental Baseline

Regulations implementing section 7 of the Act (50 C.F.R. 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. The environmental baseline also includes the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions that are contemporaneous with the consultation in progress.

The Big Quilcene River watershed drains to Quilcene Bay in west Hood Canal and includes the entire Big Quilcene River as well as four small independent streams to the south. Total watershed area is 68 square miles of which 30 percent, the headwaters, is located in the Buckhorn Wilderness. Most land below the Buckhorn is managed for timber production, with additional uses of city water supply and hatchery fish production. Below RM 4.8, the watershed changes from a steep, high-gradient stream to a braided channel with moderate gradient flowing through a wide floodplain. From the river mouth to RM 4.4, 38 percent of the riparian zone is disturbed by various land uses. Roads and dikes make up the largest percent (21 percent), with agricultural use around 10 percent (Point No Point 1999). Between RM 4.8 and RM 0.8 portions of the channel have been dredged, diked or the bank armored and below RM 0.8 the channel is diked.

The hatchery is located at RM 2.8. The hatchery complex consists of various buildings used for hatchery operations, fish rearing raceways, water supply and treatment structures, a fish ladder and an electric fish barrier. A 24-inch ductile iron water treatment pipeline is buried adjacent to the work area, traversing the riverbank and leading to a pollution abatement pond outside the project area.

Upstream of the hatchery building and in the surrounding forest areas a combination of private, State and Federal owners manage lands for timber production. This management has left little old growth forest habitat in the vicinity of the project area. At the project site itself, riparian vegetation is dominated by young alder trees and shrubs, with very little herbaceous cover. The eroding bank appears to be composed of a mix of native soils and loose fill that may have been imported during construction of the water treatment pipeline. Bank erosion is likely due to a combination of factors (including flooding, high flows directed against the outside bend at this point, bank armoring at the bridge just downstream of the project site) working on soils that were previously disturbed.

High flows in the Big Quilcene River typically occur during the winter, from November through January, with smaller peaks during spring freshets. Based on a 6-year period of record (1994-1999) at USGS gauge No. 12052210 at about RM 9.4, annual peak flows ranged from approximately 1,440 cubic feet per second (cfs) to about 1,799 cfs. During the main fish migration and spawning period the discharge below the diversion dam averaged 30 cfs. The city of Port Townsend currently has an agreement to reduce or eliminate their water withdrawal when flow falls to 25 cfs in order to keep a sufficient water level over spawning habitat.

Approximately 300 feet of the riverbank and channel margin at the toe of the slope would be affected by the proposed project. Instream habitat in this reach is predominantly riffle and glide. The substrate is cobble/boulder substrate, with some patches of recently-deposited gravel/cobble and other areas of exposed clay hardpan. Very little LWD is present and the young alder/shrub vegetation along the bank provides very little shade or cover. Habitat quality for spawning or rearing salmonids is limited in part by a flashy hydrograph and large amounts of sediment moving through the system.

On March 25, 1999, NOAA Fisheries announced the listing of the Hood Canal summer-run Evolutionarily Significant Unit (ESU) of chum salmon as threatened under the ESA (Federal Register Vol. 64, No. 57). The listing was based on the conclusion of the BRT whose major concern was the strong downward trends in abundance shown by most of the spawning populations over the past 30 years. Although some streams within the ESU had increased escapement during 1995-96, the increase was concentrated in a small number of streams and had much to do with the enhancement program on the Big Quilcene River started in the 1992 brood year, and the decrease of incidental catch from the depleted coho fishery. Other threats to the continued existence of these populations include the degradation of spawning habitat, low water flows, and incidental harvest in salmon fisheries in the surrounding waters.

HCS chum spawn in the mainstem of the Big Quilcene River up to RM 2.8 where the hatchery weir prevents further passage; however the majority of the spawning occurs between RM 0.75 and RM 1.25 (pers. Comm., Larry Telles, Assistant Manager, QNFH, 12/01/2000). Historical spawning reaches may have continued up to RM 5.0 on the mainstem (USDA 1994). Due to low flows during summer chum runs, it is unlikely that spawning historically occurred in the nearby tributaries.

The Quilcene National Fish Hatchery recorded 433 summer-run chum salmon during the year 2000. Based on this number, the total run size is estimated to be approximately 5,125 (Larry Telles, pers. comm., QNFH manager, 12/20/2000). Historical spawning escapement of the Big Quilcene River shows a highly variable return with steady decline from 1978 (2,978 fish) to 1989 when only one fish was recorded. In 1992 the supplementation program began, using broodstock collected from the tribal coho fishery in the bay, in-river collection, and fish captured at the hatchery. Average spawning escapement for the period 1992-1998 was 3,652, with a high of 9,361 and a low of 147 in 1993 (WDFW et al 2000). These numbers include both natural spawning and the broodstock for the hatchery.

2.3 Analysis of Effects

2.3.1 Effects of the Proposed Action

Rivers are dynamic systems that perpetually alter their courses in response to multiple physical criteria. Houses, roads, and other structures constructed along waterways are subject to flooding and undercutting from these natural changes in the stream course. Structural embankment hardening has been a typical means of protection for structures along waterways. Adverse effects to waterways from revetment installation include simplification of stream channels, alteration of hydraulic processes, and prevention of natural channel adjustments (Schmetterling *et al*. 2001; Spence *et al*. 1996). As erosive forces affect different locations and bank hardening occurs in response, the river eventually attains a continuous fixed alignment lacking habitat complexity (COE 1977). Riprap bank stabilization has been identified as a primary factor in the decline of salmon (Schmetterling *et al*. 2001; FWS 2000).

Fish habitats are enhanced by the diversity of habitats at the land-water interface and adjacent bank (Schmetterling *et al*. 2001; COE 1977). Streamside vegetation provides shade that reduces water temperature. Overhanging branches provide cover from predators. Organisms that fall from overhanging branches may be preyed upon by fish, or provide food sources for other prey organisms. Immersed vegetation, logs, and root wads provide points of attachment for aquatic prey organisms, shelter from swift currents during high flow events, retain bed load materials, and reduce flow velocity.

The most desirable method of bank protection is revegetation (COE 1977). However, revegetation alone can seldom stabilize banks steeper than 3:1 (horizontal:vertical) or areas of high velocity (COE 1977). Although they are biologically less desirable, fixed structures provide the most reliable means of bank stability. The use of structural measures should be a last resort. Combining structural measures (i.e., sloped riprap or mechanically stabilized earth walls), vegetation and LWD is preferable to a structural solution without vegetation (COE 1977). Beamer and Henderson (1998) suggest that the inclusion of natural bank elements with bank protection may minimize some site-level impacts of bank modification.

The habitat functions that can potentially be affected by the proposed construction include water quality (temperature, sediment, and chemical contamination), gravel recruitment, LWD recruitment, invertebrate production and stream hydraulics.

Temperature

Water temperatures may be increased by construction activities. Vegetation removal impacts will occur along 300 feet of the project site. There is a paucity of stream bank vegetation at the project site due to the disturbed nature of the site. Two deciduous trees, diameter greater than 12 inches, will be removed to facilitate equipment access and bank contouring. These trees will contribute to the LWD component of the project.

The replacement of any existing vegetation with rock has the potential to elevate stream temperature. Rock riprap may function as a conductive heat source. The nature of the substrate may affect heat transfer, and bedrock transfers heat more efficiently than gravels (Spence *et al.* 1996). Therefore, the greater the mass available to receive solar radiation the greater the heating potential. Heat collected by the rock during the day elevates night-time temperatures thereby dampening diel temperature fluctuations and elevating the daily maxima.

Existing vegetation provides minimal direct shade during low flow periods. However, removal of existing vegetation and replacement with rock may contribute to stream temperature increases via heat conduction for several years following the action. While NOAA Fisheries does not expect the proposed action by itself will result in a measurable increase in stream temperature, the action may contribute to any cumulative effect resulting from other temperature-influencing actions within the watershed. The proposed installation of vegetated geogrid above the rock toe planted with willow and other native species should provide functional shade on-site within approximately 10 to 15 years or less. Therefore, while there is some potential for short-term impacts to water temperature resulting from this project the long-term outlook is to recover from those impacts with an improved riparian shading function.

Sediment

Sedimentation impacts of this project are expected to be minimal. Excavation of the toe-rock trench will occur in the de-watered channel. This project activity, contained within the de-watered section, will prevent short-term releases of sediment although some sediment release would be expected as the project site is wetted and some sediment is transported downstream at the re-introduction of the river to the project site. Fine sediment introduced into a water body can cause turbidity. An increase in turbidity may affect fish and filter-feeding macro-invertebrates downstream of the work site. At moderate levels, turbidity has the potential to adversely affect primary and secondary productivity; at higher levels, turbidity may interfere with feeding and may injure and even kill both juvenile and adult fish (Spence *et al.* 1996, Berg and Northcote 1985).

To minimize the potential for stream turbidity and direct impacts to fish, work will occur during the WDFW recommended in-water work window (July 15 to September 1). During this window, river flows are typically low, fish presence is reduced, and rainfall is minimal. Low flows re-direction will allow most of the work to occur in the dry, thereby reducing indirect (turbidity) and direct impacts to fish. Fish presence is minimal with rearing juveniles of non-listed species (coho) potentially present, but no adult spawning or egg incubation occurring. The low probability of rainfall reduces the likelihood that sediment will be transported beyond the project area. Precipitation probability increases into the fall period, as does the potential presence of returning adult chum salmon.

Chemical Contamination

As with all construction activities, accidental release of fuel, oil, and other contaminants may occur. Operation of the back-hoes, excavators, and other equipment requires the use of fuel, lubricants, etc., which, if spilled into the channel of a water body or into the adjacent riparian zone, can injure or kill aquatic organisms. Petroleum-based contaminants (such as fuel, oil, and some hydraulic fluids) contain poly-cyclic aromatic hydrocarbons (PAHs) which can cause acute toxicity to salmonids at high levels of exposure and can also cause chronic lethal and acute and chronic sublethal effects to aquatic organisms (Neff 1985).

To minimize the potential for chemical contamination, equipment will work from above the banks of the channel or from within the coffer dam de-watered site. Equipment will be removed from the immediate project site for refueling and maintenance. If the project site is properly managed the likelihood of chemical contamination as discussed above is minimized.

Gravel Recruitment

Streams continuously transport eroded material downstream from areas of erosion to areas of deposition. Transport varies with discharge and is therefore episodic (Kondolf 1994). Armoring streambanks limits lateral channel changes and gravel recruitment (Schmetterling *et al*. 2001). Bank hardening may sequester on-site gravel sources from capture by the active river system and cause downcutting due to increased flow velocities. Downcutting may extend well upstream or downstream, and result in the perching of historic depositional gravel layers above the OHWM, thereby reducing gravel capture rates within the system. A net loss of gravel recruitment to the system may ultimately result in the loss of sufficient gravels to support successful salmon spawning. The cumulative effect of gravel isolation may lead to loss of enough sources that the waterway becomes gravel-limited.

The NOAA Fisheries is not aware of any information indicating the subject waterway is gravel-limited. To the contrary the presence of gravel traps in the lower river are the anthropogenic response to ‘excess’ gravels that accumulate in diked and manipulated river systems. An assessment of anadromous fish use above the hatchery site does indicate a lack of suitable spawning substrate (Zajac 2002). The bank below the OHWM at the project site does not exhibit obvious gravel recruitment potential. It is likely, however, that with the inclusion of the groins and LWD that affect flow and transport capacity that capture and accumulation of gravels will occur at the project site creating a long term improvement to spawning capacity.

Large Woody Debris Recruitment

Large wood is central to determining channel morphology and biological condition in many Pacific Northwest streams (Spence *et al.* 1996). Pool formation, gravel and organic material retention, velocity disruption, and predatory cover for fish are all strongly reliant on LWD. Other than natural mortality, sources of large wood recruitment to streams include bank erosion, snow avalanche, mass wasting events, blow down, and transport from upstream (Gurnell *et al.* 1995). The removal of riparian vegetation can simplify aquatic habitat and reduce LWD recruitment potential (Schmetterling *et al*. 2001).

The proposed action may effect large wood in the subject reach, and influence downstream reaches. Bank hardening will reduce the large wood recruitment potential on site by artificially preventing capture of riparian vegetation by bank erosion. Simplification of the bank habitat may reduce retention of LWD transported on site from upstream sources. The proposed clearing and contouring of the upper bank will result in removal of two trees as noted above. The bank protection project with the inclusion of the vegetated geogrid will allow large wood to develop over time, and plantings of native willow and volunteer conifer will provide future sources. Since bank erosion will be eliminated as a delivery vector, recruitment is anticipated to be limited to natural mortality and blow down.

Invertebrate Production

Invertebrate/aquatic insect production will be temporarily diminished as a result of this project. In the project area, from the hatchery spillway to the downstream end of the bank protection, the left bank will be de-watered during the project construction. Additionally, the construction equipment will be working up and down the stream bed placing the toe-rock portion of the project. Invertebrate production will interrupted and diminished during the period of site de-watering. At the same time right bank portion of the river will also be impacted during project construction. An inflated coffer dam will separate that part of the river that will continue to carry river flow during the project. The bed of the river along the right bank will be sealed with an impermeable layer to assure the effective sealing and de-watering of the project site. During this period invertebrate production will be severely impacted from the isolation of bed material from river flows.

These loss of invertebrate production will contribute to the take of listed species as an impact to the food web. Invertebrate/aquatic insect production is seldom affected in the long-term, however. Consequently only minimal and short-term impacts are expected to occur. The short-term pulse of suspended solids that is likely to result when the river is allowed to return through the project site is also unlikely to produce any long-term negative impact to invertebrate production.(Spence et al, 1996)

Stream Hydraulics

The placement of toe rock (riprap) along a 300-foot length of streambank and the placement of four rock groins will impact stream hydraulics. Simplification of the embankment may result in velocity acceleration and channel incision, or displace erosion to another site (Schmetterling *et al*. 2001). However, Beamer and Henderson (1998) found no significant difference in water surface velocities between natural and riprapped banks. Habitat simplification also reduces refugia sites for fish (i.e., undercut banks, debris dams), which assist in predator avoidance and maintenance of position during high flow events. Construction of the groins will create some different habitat niches in and around the groins. While data indicates habitat use of riprapped banks by yearling and older trout species may be equal to or higher than natural banks, use by sub-yearling trout, coho, and chinook salmon is lower (Beamer and Henderson 1998; Peters *et al*. 1998). Size of material is also relevant, as greater fish densities have been generally correlated with larger rock (Beamer and Henderson 1998; Lister *et al*. 1995). Where rock riprap exists, Lister *et al*. (1995) found that embankments roughened by the placement of 1.0 to 1.5 meter diameter rock along the toe of the bank appeared to have greater salmonid rearing densities for all species except yearling steelhead. Alteration of habitat may favor introduced fish species (Schmetterling *et al*. 2001), which may displace or prey upon native species.

The NOAA Fisheries expects that the proposed action will result in additional sites of erosion and fish displacement, though project design features (e.g., irregular rock toe, LWD placement, tree planting) may provide limited velocity reduction and future refugia benefits to reduce adverse affects.

2.3.2 Cumulative Effects

Cumulative effects are defined as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation" (50 C.F.R. 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Non-Federal activities of the type identified as factors for decline by NOAA Fisheries occur within the Big Quilcene River basin. These include continuing water withdrawal for private and municipal purposes. Forest land management (logging) is still a predominant occurrence in the watershed. While large scale urbanization impacts are not prevalent, stream channelization through diking has occurred in the lower reaches. The impacts normally associated with diking; bed aggradation, floodplain development, exacerbated flooding and flood related dike breeching have all occurred. With a projected 34 percent increase in human population over the next 20 years in Washington (DNR 2000) these factors are expected to increase. Thus, NOAA Fisheries assumes that future private and State actions will continue within the basin, but at increasingly higher levels as population density climbs. An increase in development in the watershed will increase the likelihood of future projects like this proposed action needed to protect roads and other capitol improvements. NOAA Fisheries does note a growing awareness to the benefits of levee or dike breeching/setbacks. Limited levee breeching has occurred in the watershed to allow river access to it's historical floodplain.

2.4 Conclusion

After reviewing the current status of HCS chum salmon, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, the NOAA Fisheries has determined that the Big Quilcene River Bank Protection and Habitat Improvement Project, as proposed, is not likely to jeopardize the continued existence of the HCS chum salmon. This finding is based, in part, on incorporation of best management practices (BMPs) into the proposed project design (i.e., WDFW in-water work window, site revegetation, site de-watering, and individual rock placement), but also on the following considerations: 1) Full bank hardening is not proposed but rather a toe-rock application with vegetated geogrid bank has been limited to that length of bank necessary to protect the access road and pollution abatement pipeline; 2) willow plantings have been incorporated into the geogrid embankment to provide future shading and soil binding; 3) revegetation of the banks will provide an allochthonous material source and assist in limiting potential detrimental water temperature affects resulting from direct solar radiation of the water surface; and 4) the proposed action will not appreciably reduce the functioning of the ESU's already impaired habitats, or retard the long-term progress of impaired habitats toward properly functioning condition (PFC).

2.5 Re-initiation of Consultation

This concludes formal consultation on these actions in accordance with 50 C.F.R. 402.14(b)(1). Reinitiation of consultation is required: (1) If the amount or extent of incidental take is exceeded; (2) the action is modified in a way that causes an effect on the listed species that was not previously considered in the biological assessment and this Opinion; (3) new information or project monitoring reveals effects of the action that may affect the listed species in a way not previously considered; or (4) a new species is listed or critical habitat is designated that may be affected by the action (50 C.F.R. 402.16).

2.6 Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4 (d) of the Act prohibit the take of endangered and threatened species without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct of listed species without a specific permit or exemption (50 C.F.R. 217.12). "Harm" is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, spawning, rearing, migrating, feeding, and sheltering. Harass is defined as actions that created the likelihood of injuring listed species to such an extent as to significantly alter normal behavior patterns which include, but are not limited to breeding, feeding, and sheltering. Incidental take is take of listed animal species that results from, but is not the purpose of, the Federal agency or the applicant carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of, the agency action is not considered prohibited taking provided that such takings is in compliance with the terms and conditions of this incidental take statement.

An incidental take statement specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary to minimize impacts and sets forth terms and conditions with which the action agency must comply in order to implement the reasonable and prudent measures.

2.6.1 Amount or Extent of Take

The NOAA Fisheries anticipates that the proposed action covered by this Opinion is reasonably certain to result in the incidental take of juvenile HCS chum salmon resulting from the long-term removal of potential natural rearing habitat due to the use of riprap in this bank hardening project. Effects of actions such as these are largely unquantifiable in the short term. The effects of these activities on population levels are also largely unquantifiable and not expected to be measurable in the long term.

Therefore, even though NOAA Fisheries expects some low level of incidental take to occur due to the action covered by this Opinion, the best scientific and commercial data available are not sufficient to enable NOAA Fisheries to estimate a specific amount of incidental take to the species itself. In instances such as this, NOAA Fisheries designates the expected level of take in terms of the extent of take allowed. Therefore, NOAA Fisheries limits the area of allowable incidental take during construction to the distance encompassed in the actual project site. Take resulting from the release of sediment when the coffer dams are removed is not expected to exceed 1.0 mile downstream. Incidental take occurring beyond these areas is not authorized by this consultation.

2.6.2 Reasonable and Prudent Measures

The NOAA Fisheries believes that the following reasonable and prudent measures are necessary and appropriate to minimize take of the above species. Minimizing the amount and extent of take is essential to avoid jeopardy to the listed species.

1. The FWS will minimize the likelihood of incidental take from construction activities in or near watercourses by implementing pollution and erosion control measures.

2. The FWS will minimize the likelihood of incidental take associated with impacts to riparian and instream habitats by avoiding or replacing lost riparian and instream functions.

3. The FWS will minimize the likelihood of incidental take associated with instream work by restricting work to recommended in-water work periods.

2.6.3 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the FWS must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1. To implement reasonable and prudent measure No. 1 (pollution and erosion control), above, the FWS shall ensure that:

    a. All exposed or disturbed areas will be stabilized to prevent erosion.

i. Areas of bare soil within 150 feet of waterways, wetlands or other sensitive areas will be stabilized by native seeding,[2] mulching, and placement of erosion control blankets and mats, if applicable, as quickly as reasonable after exposure.

ii. Seeding and revegetation applications shall occur during and early fall planting window. Seeding outside the growing season will not be considered adequate nor permanent stabilization.

iii. All other areas will be stabilized as quickly as reasonable, but within 14 days of exposure.

b. Material removed during excavation will only be placed in locations where it cannot enter streams or other water bodies.

c. Heavy equipment will be fueled, maintained and stored as follows.

i. All vehicles operated within 150 feet of any stream or water body will be inspected daily for fluid leaks before leaving the vehicle staging area. Any leaks detected will be repaired before the vehicle resumes operation.

ii. When not in use, vehicles will be stored in the vehicle staging area.

d. No pollutants of any kind (e.g., petroleum products, wet concrete) shall contact the area below the bankfull elevation.[3]

e. No surface application of fertilizer will be used within 50 feet of any stream channel as part of this permitted action.

2. To implement reasonable and prudent measure No. 2 (riparian and instream habitats), above, the FWS shall ensure that:

a. Alteration or disturbance of the stream banks and existing riparian vegetation shall be minimized.

b. Disturbed soils shall be seeded (see Term and Condition 1.a.ii.).

c. Minimize the use of rock and riprap. When rock must be used with other erosion controls below bankfull elevation, class 350 metric or larger rock is preferred.

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[2] By Executive Order 13112 (February 3, 1999), Federal agencies are not authorized to permit, fund or carry out actions that are likely to cause, or promote, the introduction or spread of invasive species. Therefore, only native vegetation that is indigenous to the project vicinity, or the region of the state where the project is located, shall be used.

[3] "Bankfull elevation" herein is interpreted to mean the bank height inundated by a 2-year average recurrence interval and may be estimated by morphological features such average bank height, scour lines and vegetation limits.

d. Revegetation plantings will use only natural vegetation.[4]

e. Any instream large wood moved or altered during construction will stay on site.

f. Plantings will achieve an 80 percent target survival success after three years.
   i. If success standard has not been achieved after three years, FWS will propose an alternative plan that addresses temporal loss of function.
   ii. Plant establishment monitoring will continue until site restoration success has been achieved.

g. All initial plantings shall occur prior to April 15, 2003.

3. To implement Reasonable and Prudent measure No.3 (In-water work window), above, the FWS shall ensure that:

   a. All in-water work will be completed within the WDFW approved in-water work period (July 1 - September 1). Extensions of the in-water work period should not be anticipated except under extenuating circumstances and must be approved in advance by NOAA Fisheries in writing.

3.0 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

3.1 Background

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance Essential Fish Habitat (EFH) for those species regulated under a Federal fisheries management plan. Pursuant to the MSA:

1. Federal agencies must consult with NOAA Fisheries on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (§305(b)(2));

2. NOAA Fisheries must provide conservation recommendations for any Federal or State action that would adversely affect EFH (§305(b)(4)(A));

3. Federal agencies must provide a detailed response in writing to NOAA Fisheries within 30 days after receiving EFH conservation recommendations. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NOAA Fisheries EFH

[4] By Executive Order 13112 (February 3, 1999), Federal agencies are not authorized to permit, fund or carry out actions that are likely to cause, or promote, the introduction or spread of invasive species. Therefore, only native vegetation that is indigenous to the project vicinity, or the region of the state where the project is located, shall be used.

conservation recommendations, the Federal agency must explain its reasons for not following the recommendations (§305(b)(4)(B)).

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA §3). For the purpose of interpreting this definition of EFH: Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle (50 C.F.R. 600.10). Adverse effect means any impact which reduces quality and/or quantity of EFH, and may include direct (*e.g.*, contamination or physical disruption), indirect (*e.g.*, loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 C.F.R. 600.810).

EFH consultation with NOAA Fisheries is required regarding any Federal agency action that may adversely affect EFH, including actions that occur outside EFH, such as certain upstream and upslope activities.

The objectives of this EFH consultation are to determine whether the proposed action would adversely affect designated EFH and to recommend conservation measures to avoid, minimize, or otherwise offset potential adverse effects to EFH.

3.2 Identification of EFH

Pursuant to the MSA the Pacific Fisheries Management Council (PFMC) has designated EFH for three species of federally-managed Pacific salmon: chinook (*Oncorhynchus tshawytscha*); coho (*O. kisutch*); and Puget Sound pink salmon (*O. gorbuscha*)(PFMC 1999). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC 1999), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). Detailed descriptions and identifications of EFH for salmon are found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). Assessment of potential adverse effects to these species' EFH from the proposed action is based, in part, on this information.

3.3 Proposed Actions

The proposed action and action area are detailed above in Section 1.2 and 1.3 of this Opinion. The action area includes habitats that have been designated as EFH for various life-history stages of chinook and coho and Puget Sound pink salmon.

3.4 Effects of Proposed Action

As described in detail in Section 2.3.1 of this Opinion, the proposed action may result in short- and long-term adverse effects to habitat. These adverse effects are:

1. Temporary loss of rearing habitat for juvenile coho.

2. Temporary loss of aquatic insects (a prey base for listed species) due to physical loss of existing habitat at the structure placement sites and sedimentation of downstream instream habitat and short-term impacts of the stream diversion.

3. Temporary increases in suspended sediment as a result of instream excavation.

4. Temporary risk of contamination of waters through accidental spills or leaks of petroleum products, wet concrete, and fertilizers.

3.5 Conclusion

NOAA Fisheries concludes that the proposed action would adversely affect designated EFH for chinook and coho and Puget Sound pink salmon.

3.6. EFH Conservation Recommendations

Pursuant to Section 305(b)(4)(A) of the MSA, NOAA Fisheries is required to provide EFH conservation recommendations to Federal agencies regarding actions which may adversely affect EFH. NOAA Fisheries believes that the conservation measures described in the BA will minimize adverse effects Nos.1-3, as described above, to the maximum extent practicable and do not require additional conservation recommendations. To minimize the remaining adverse effects to designated EFH for Pacific salmon, suspended sediment and contamination of waters, NOAA Fisheries recommends that the FWS adopts Terms and Conditions 1a-e, as described in Section 2.6.3 of this document.

3.7 Statutory Response Requirement

Pursuant to the MSA (§305(b)(4)(B)) and 50 C.F.R. 600.920(j), Federal agencies are required to provide a detailed written response to NOAA Fisheries' EFH conservation recommendations within 30 days of receipt of these recommendations. The response must include a description of measures proposed to avoid, mitigate, or offset the adverse impacts of the activity on EFH. In the case of a response that is inconsistent with the EFH conservation recommendations, the response must explain the reasons for not following the recommendations, including the scientific justification for any disagreements over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects.

3.8. Supplemental Consultation

The FWS must reinitiate EFH consultation with NOAA Fisheries if the proposed action is substantially revised in a manner that may adversely affect EFH, or if new information becomes available that affects the basis for NOAA Fisheries' EFH conservation recommendations (50 C.F.R. 600.920(k)).

4.0 REFERENCES

Allen, B. 1974. Early marine life history of Big Qualicum River chum salmon. Pp. 137-148 IN: D.R. Harding (ed.). Proceedings of the 1974 Northeast Pacific Pink and Chum Salmon Workshop. Dep. Env., Fish., Vancouver, B.C.

Beamer, E.M. and R. A. Henderson. 1998. Juvenile salmonid use of natural and hydromodified stream bank habitat in the mainstem Skagit River, northwest Washington. Miscellaneous Report. Skagit System Cooperative, LaConner, WA.

Bakkala, R.G. 1970. Synopsis of biological data on the chum salmon (Oncorhynchus keta). FAO species synopsis. No. 41. Circ. 315. 89 pp.

Barlow, J.P. 1958. Spring changes in phytoplankton abundance in a deep estuary, Hood Canal, Washington. J. Mar. Res. 17:53-67.

Bax, N.J., E.O. Salo, B.P. Snyder, C.A. Simenstad, and W.J. Kinney. 1978. Salmonid outmigration studies in Hood Canal. Univ. Washington, Fish. Res. Inst., Final Report FRI-UW-7819. 128 pp.

Bax, N.J., E.O. Salo and B.P. Snyder. 1979. Salmonid outmigration studies in Hood Canal. Final Rep., Fish. Res. Inst., Univ. Washington. FRI-UW-7921. 89 pp.

Bax, N.J., E.O. Salo, and B.P. Snyder. 1980. Salmonid outmigration studies in Hood Canal. Final Rep., Fish. Res. Inst., Univ. Washington. FRI-UW-8010. 55 pp.

Bax, N.J. and C.J. Whitmus. 1981. Early marine survival and migratory behavior of juvenile chum salmon released from the Enetai Hatchery, Washington in 1980. Final Rep., Fish. Res. Inst., Univ. Washington. FRI-UW-8109. 48 pp.

Bax, N.J. 1982. Seasonal and annual variations in the movement of juvenile chum salmon through Hood Canal, Washington, p. 208-218. In: E.L. Brannon and E.O. Salo (eds.). Proceedings of the Salmon and Trout Migratory Behavior Symposium. School of Fisheries, Univ. Washington, Seattle, WA

----------- 1983a. Early marine mortality of marked juvenile chum salmon (Oncorhynchus keta) released into Hood Canal, Puget Sound, Washington, in 1980. Can. J. Fish. Aquat. Sci. 40:426-435.

----------- 1983b. The early marine migration of juvenile chum salmon (Oncorhynchus keta) through Hood Canal - its variability and consequences. Ph.D. Dissertation, Univ. Washington, Seattle. 196 pp.

Beamer, E.M., and R.A. Henderson. 1998. Juvenile salmonid use of natural and hydromodified stream bank habitat in the mainstem Skagit River, northwest Washington. Prepared for: United States Army Corps of Engineers, Seattle District, Environmental Resource Section, Seattle, Washington. 51 p.

Berg, L. and T.G. Northcote. 1985. "Changes In Territorial, Gill-Flaring, and Feeding Behavior in Juvenile Coho Salmon (*Oncorhynchus kisutch*) Following Short-Term Pulses of Suspended Sediment." Canadian Journal of Fisheries and Aquatic Sciences 42: 1410-1417.

Feller, R.J. 1974. Trophic analysis of juvenile pink and chum salmon from Puget Sound, 1970-72. Pp 149-160 In: D.R. Harding (ed.). Proc. 1974 NE Pac. Pink and Chum Salmon Workshop. Dept. Env. Fish., Vancouver, British Columbia.

Gerke, R.J. and V.W. Kaczynski. 1972. Food of pink and chum salmon in Puget Sound, Washington. Wash. Dept. Fish. Tech. Rept. No.10. 27 pp.

Gurnell, A.M., K.J. Gregory, and G.E. Petts. 1995. The role of coarse woody debris in forest aquatic habitats: implications for management. Aquatic Conservation: Marine and Freshwater Ecosystems, 5:143-166.

Hoar, W.S. 1951. The behavior of chum, pink and coho salmon in relation to their seaward migration. J. Fish. Res. Bd. Can. 8(4):241-263.

Iwata, M. 1982. Transition of chum fry into saltwater. Pages 204-207. In: E.L. Brannon and E.O. Salo (eds.). Proceedings of the Salmon and Trout Migratory Behavior Symposium. School of Fisheries, Univ. Washington, Seattle, WA

Johnson, O.W., W.S. Grant, R.G. Cope, K. Neely, F.W. Waknitz, and R.S. Waples. 1997. Status review of chum salmon from Washington, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-32, 280 p.

Kondolf, G.M. 1994. Geomorphic and environmental effects of instream gravel mining. *In*: Landscape and Urban Planning, 28:225-243, Elsevier Science B.V., Amsterdam.

Koski, K.V. 1975. The survival and fitness of two stocks of chum salmon (Oncorhynchus keta) from egg deposition to emergence in a controlled stream environment at Big Beef Creek. Ph.D. thesis. College of Fish., Univ. Washington. 212 pp.

-------------- 1981. The survival and quality of two stocks of chum salmon (Oncorhynchus keta) from egg deposition to emergence. Pages 330-333 in R. Lasker and K. Sherman (eds.). The early life history of fish: recent studies. Rapp. P.-v. Reun. Cons. Int. Explor. Mer. 178 pp.

Lampsakis, N. 1994. Entry pattern information for Puget Sound management periods document. Memorandum to Tim Tynan, Washington Dept. Fish and Wildlife and Keith Lutz, Northwest Indian Fisheries Commission. Point No Point Treaty Council, Kingston, Washington. 25 pp.

LeClair, L.L. 1995. WDFW Memorandum to Tim Tynan. 1995 catch area 20 chum salmon bycatch. Wash. Dept. Fish Wildlife, Research and Development Div., Genetics Unit.

---------------- 1996. WDFW Memorandum to Tim Tynan (August 29, 1996). 1996 catch area 20 chum salmon by-catch. Wash. Dept. Fish Wildlife, Research and Development Div., Genetics Unit.

Lister, D.B., R.J. Beniston, R. Kellerhals, and M. Miles. 1995. Rock size affects juvenile salmonid use of streambank riprap. Pages 621-634 *in* C.R. Thorne, S.R. Abt, F.B.J. Barends, S.T. Maynard, and K.W. Pilarczyk, eds. River, coastal and shoreline protection: erosion control using riprap and armourstone. John Wiley & Sons, Ltd., New York.

Mason, J.C. 1974. Behavioral ecology of chum salmon fry in a small estuary. J. Fish. Res. Bd. Can. 31:83-92.

Myers, K.W. 1993. New conceptual models of high-seas migrations of pink and chum salmon. Pp. 83-96 in Alaska Sea Grant (ed.). Proceedings 1993 N.E. Pacific Pink and Chum Salmon Workshop. Alaska Sea Grant College Program Rep. No. 94-02.

Neave, F. 1955. Notes on the seaward migration of pink and chum salmon fry. J. Fish. Res. Bd. Can. 12:369-374.

Neave, F., T. Yonemori and R.G. Bakkala. 1976. Distribution and origin of chum salmon in offshore waters of the North Pacific Ocean. Internat. N. Pacific Fish. Comm., Bulletin No. 35. Vancouver, B.C. 79 pp.

Neff, J.M. 1985. Polycyclic aromatic hydrocarbons. *In*: Fundamentals of aquatic toxicology, G.M. Rand and S.R. Petrocelli, pp. 416-454. Hemisphere Publishing, Washington, D.C.

Peters, R.J., B.R. Missildine, and D.L. Low. 1998. Seasonal fish densities near river banks stabilized with various stabilization methods. U.S. Fish and Wildlife Service, Lacey, Washington. 32 p.

PFMC (Pacific Fishery Management Council). 1999. Amendment 14 to the Pacific Coast Salmon Plan. Appendix A: Description and Identification of Essential Fish Habitat, Adverse Impacts and Recommended Conservation Measures for Salmon. Portland, Oregon.

Phelps, S.R., L.L. LeClair, S. Young, and H.L. Blankenship. 1995. Genetic diversity patterns of chum salmon in the Pacific Northwest. Can. J. Fish. Aqua. Sci. 51(1): 65-83.

Point No Point Treaty Council, skokomish Tribe, Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Wahington Department of fish and Wildlife. 1999. Hood Canal/Eastern Strait of Juan De Fuca summer Chum Habitat Recovery Plan. Final Draft. March 23, 1999.

Salo, E.O. 1991. Life history of chum salmon (Oncorhynchus keta). Pages 231-310 in C. Groot and L. Margolis, editors. Pacific salmon life histories. UBC Press, Univ. British Columbia, Vancouver, British Columbia.

Schreiner, J.U. 1977. Salmonid outmigration studies in Hood Canal, Washington. M. S. Thesis. Univ. Washington. 91 pp.

Schroder, S.L. 1977. Assessment of production of chum salmon fry from the Big Beef Creek spawning channel. Univ. Washington, Fish. Res. Inst., Final Rep., FRI-UW-7718. 77 pp.

------------------ 1981. The role of sex selection in determining overall mating patterns and mate choice in chum salmon. Ph.D thesis. Univ. Washington, Seattle. 274 pp.

Sele, B. 1995. Status of summer chum salmon in the Strait of Juan de Fuca (Draft document). Jamestown S`Sklallam Tribe, Point No Point Treaty Council. Sequim, WA.

Simenstad, C.A., W.J. Kinney, S.S. Parker, E.O. Salo, J.R. Cordell, and H. Buechner. 1980. Prey community structure and trophic ecology of outmigrating juvenile chum and pink salmon in Hood Canal, Washington. Univ. Washington, Fish. Res. Inst., Final Report FRI-UW-8026. 111 pp.

Schmetterling, D.A., C.G. Clancy, and T.M. Brandt. 2001. Effects of riprap bank reinforcement on stream salmonids in the western United States. Fisheries 26(7):6-13.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. An Ecosystem Approach to Salmonid Conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, Oregon. (Available from the National Marine Fisheries Service, Portland, Oregon). 356 p.

Telles, L. 1996. Memorandum to Tim Tynan - Temperature unit developmental data for 1994 brood year Big Quilcene River summer chum and Big Quilcene River temperature time series, fall 1992. Quilcene Nat. Fish. Hatch., U.S. Fish Wildlife Ser., Quilcene, WA.

Tynan, T. 1992. Hood Canal early chum harvest and escapement assessment: a review of Hood Canal early chum escapements and inside Hood Canal commercial net fishery harvests (1969-91) with recommendations for short and long term management measures to assist stock rebuilding. Wash. Dept. Fisheries, Puget Sound Salmon Management Unit, Olympia, WA. 57 pp.

------------ 1997. Life history characterization of summer chum salmon populations in the Hood Canal and eastern Strait of Juan de Fuca regions. Report No.H97-06. Assessment and Development Division, Hatcheries Program. Washington Department of Fish and Wildlife. Olympia, WA.

USACE (United States Army Corps of Engineers). 1977. Nehalem Wetlands Review: A Comprehensive Assessment of the Nehalem Bay and River (Oregon). U.S. Army Engineer District, Portland, Oregon. [Page count unknown].

USFS (US forest Service). 1994. Final Supplemental Environmental Impact Statement on Management of Habitat for late-Successional and Old-Growth Forest Related Species Within the Range of Northern Spotted Owl. USDA forest service, USDI Bureau of Land Management, and Fish and Wildlife Service. February 1994.

USFWS (United States Fish and Wildlife Service). 2000. Draft Programmatic Biological Opinion on the Sacramento River Bank Protection Project. California/Nevada Operations Office, Sacramento, California.

Washington Department of Fisheries (WDF), Washington Department of Wildlife (WDW), and Western Washington Treaty Indian Tribes (WWTIT). 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Internal Report to Washington Dept. Fish Wildlife., 212 p.

Washington Department of Fisheries (WDF), Washington Department of Wildlife (WDW), and Western Washington Treaty Indian Tribes (WWTIT). 1994. 1992 Washington State salmon and steelhead stock inventory (SASSI). Appendix One, Puget Sound stocks. Hood Canal and Strait of Juan de Fuca volume. Internal Report to Washington Dept. Fish Wildlife., 424 pp.

Washington Dept. Fish and Wildlife. 1996. Hood Canal and Strait of Juan de Fuca summer chum 1996 status and summary of stock restoration efforts. Hatcheries and Fish Management Programs, Wash, Dept. Fish and Wildlife. Olympia, WA. 35 pp.

Washington Department of Fish and Wildlife and Point No Point Treaty Council Tribes. 2000. Summer chum salmon conservation initiative - Hood Canal and Strait of Juan de Fuca region. Washington Department of Fish and Wildlife. Olympia, WA.

Washington Department of Natural Resources (DNR). 2000. Changing Our Waterways: Trends in Washington's Water Systems. 133pp

Whitmus, C. J. 1985. The influence of size on the early marine migration and mortality of juvenile chum salmon (Oncorhynchus keta). M. S. Thesis. University of Washington. 69 pp.

Wissmar, R.C. and C.A. Simenstad. 1980. Optimal management of chum salmon based on estuarine and nearshore carrying capacity for out-migrating juveniles in Hood Canal. NSF Research grant proposal. Fish. Research. Instit. Univ. Washington, Seattle, WA. 80 pp.

Zajac, D. 2002. An assessment of anadromous fish Habitat Use Above Quilcene National Fish Hatchery in the Big Quilcene river. U.S. Fish and Wildlife Service. Lacey, Washington. 15p.